GENERIC MECHANICAL REQUIREMENTS FOR PRELIMINARY DESIGN

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Preface

This document is a Geospace Dynamics Constellation (GDC) Project configuration control board (CCB) controlled document. Changes to this document require prior approval of the GDC CCB Chairperson or designee. Proposed changes shall be submitted in the GDC Technical Data Management System (TDMS) via a configuration change request (CCR) along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

All of the requirements in this document assume the use of the word "shall" unless otherwise stated.

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Change History Log

Revision	Effective Date	Description of Changes
Revision -		

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Action Item No.	Location	Summary	Individual/ Organization Actionee

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1 INTRODUCTION

1.1 Purpose

The following sections provide a set of generic mechanical environments that may be used for the preliminary design of components and subsystems, including instruments, when the launch vehicle and spacecraft configurations are not known. These design environments should be updated when mission specific information becomes available.

1.2 Scope

The loads and environments shown in the body of this document provide an envelope of expected design loads for an unknown spacecraft/launch vehicle configuration. There is low risk that hardware will see loads that exceed the values shown once the mission specific configuration has been defined.

1.3 Reference Documentation

- GEVS, GSFC-STD-7000A General Environmental Verification Standard

2 GENERIC MECHANICAL REQUIREMENTS

2.1 Quasi-Static Design Limit Loads

The mass-acceleration curve (MAC) shown in Figure 2-1 provides a set of quasi-static limit loads that may be used for preliminary hardware design. The MAC loads provided are for the generic case in which the launch vehicle is not known. The MAC covers the peak dynamic response of the payload hardware to the low-frequency launch environment. These loads are intended to envelope flight loads for all possible spacecraft and launch vehicle configurations.

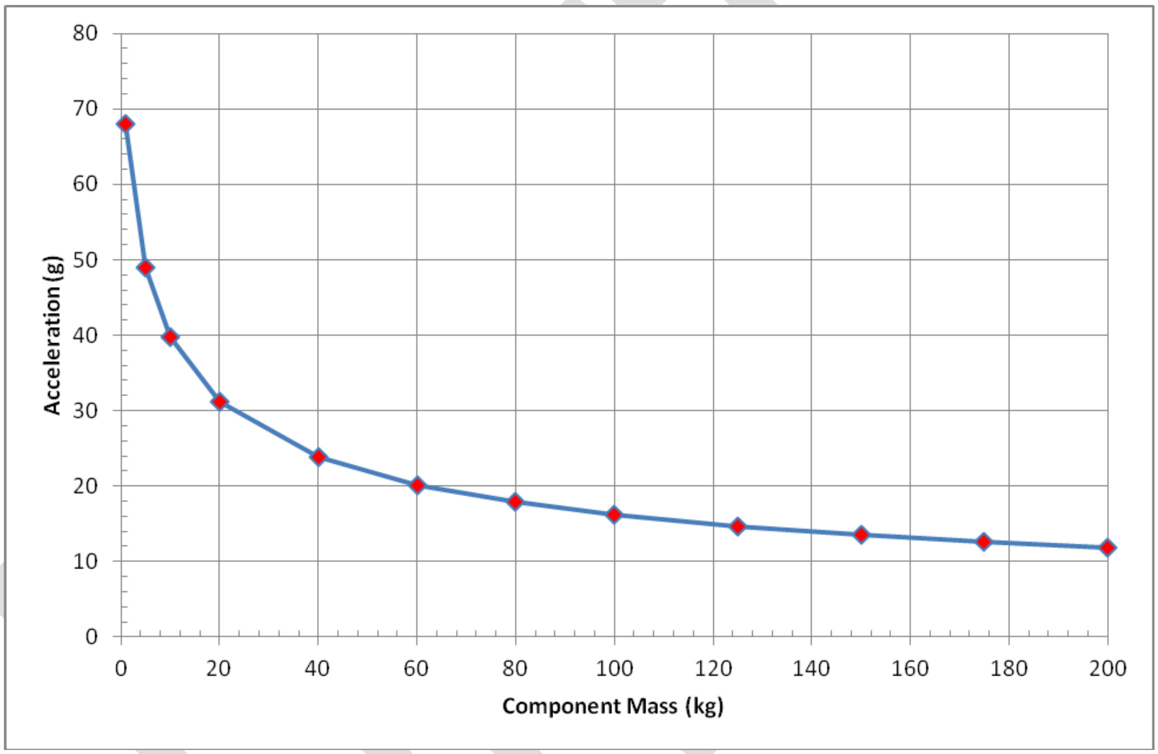

Figure 2-1: Generic Mass Acceleration Curve (MAC) – Flight Limit

The breakpoints for the MAC curve are given in Table 2-1. The loads shown in Figure 2-1 and Table 2-1 should be updated based on a launch vehicle specific set of MAC loads or the results of coupled loads analysis when this information becomes available.

MAC loads are applicable to all components and subsystems regardless of their fundamental frequency. However, the mass that should be used for deriving loads using the MAC is a function of the fundamental frequency of the component or the fundamental frequency of the structure on which the component is mounted. One should use the component mass down to the level of assembly which either has its fundamental frequency below 80 Hz or is driven by structure which has fundamental frequency below 80 Hz. For example, an electronics box with a first mode of 120 Hz which mounts to spacecraft structure with a first mode below 80 Hz would be designed based on a MAC load using the weight of the electronics box. Everything within the electronics box would be designed for the same quasi-static MAC load as the electronics box. The MAC curve should not be applied to items within the electronics box in this example.

Hardware Mass (Kg)	Limit Load (G, any Direction)
1 or less	68.0
5	49.0
10	39.8
20	31.2
40	23.8
60	20.2
80	17.8
100	16.2
125	14.7
150	13.5
175	12.6
200 or Greater	12.0

1) MAC loads should be applied in each axis independently
2) Hardware should be designed to show positive margin for limit load using the factors of safety defined in GEVS Section 2.2.5, Table 2.2-3.
3) Linear interpolation may be used between break-points to determine limit load

Table 2-1: MAC Design Limit Loads

2.2 Sine Sweep Vibration

Table 2-2 provides a generic sine environment for the preliminary design of components and subsystems. The sine sweep vibration levels shown in Table 2-2 are defined at the hardware mounting interface. The sine vibration levels shown are intended to envelope the dynamic environment for the frequency range covered by a coupled loads analysis (CLA) (normally 0-50 Hz) as well as a base-drive analysis for the frequency range from 50-100 Hz.

The sine environment has been provided primarily for reference. It is not expected that sine will be a design driver for loads as the hardware response may be limited not to exceed the quasi-static MAC loads provided in Section 2.1. The levels shown below should be updated using a combination of coupled loads results and base-drive analysis of the payload once the launch vehicle specific low-frequency environment has been defined.

Frequency	Flight Level	Protoflight/Qual Level
5 to 20 Hz	0.5 in. (double amplitude)	0.63 in (double amplitude)
20 to 100 Hz[4]	10.0 g	12.5 g

Table 2-2: Interface Sine Sweep Vibration Levels (All Axes)

1) Flight/Protoflight level sweep rate shall be 4 oct/min
2) Qualification level sweep rate shall be 2 oct/min
3) Input levels may be notched to limit component center-of-gravity (CG) response to the design limit loads specified in Table 2-1
4) Frequency range extended from 50 to 100 Hz. Verification is performed via analysis in this frequency range using a base-drive analysis.

2.3 Acoustics

A generic acoustic environment is shown in Table 2-3 . This acoustic environment should be used for preliminary design of components and subsystems if a specific launch vehicle has not been defined. While all hardware should be assessed for sensitivity to direct acoustic impingement, unless the component or subsystem has structure which is light-weight and has large surface area (typically a surface to weight ratio of < 150 in^2/lb), it is expected that the random environment specified in Section 2.4 will be the dominant high-frequency loading condition rather than the acoustic environment defined in Table 2-3.

One-Third Octave Center Frequency (Hz)	Flight Level (dB)	Qual/Protoflight Level (dB)
20	122.3	125.3
25	123.8	126.8
31.5	125.5	128.5
40	127.1	130.1
50	128.5	131.5
63	129.7	132.7
80	130.7	133.7
100	131.4	134.4
125	131.7	134.7
160	131.6	134.6
200	131.3	134.3
250	128.9	131.9
315	127.7	130.7

400	126.6	129.6
500	124.8	127.8
630	128.4	131.4
800	128.6	131.6
1000	126.9	129.9
1250	123.1	126.1
1600	117.5	120.5
2000	116.2	119.2
2500	113.6	116.6
3150	113.1	116.1
4000	112.5	115.5
5000	111.8	114.8
6300	111.0	114.0
8000	110.0	113.0
10000	109.1	112.1
OASPL	**141.5**	**144.5**

Table 2-3: Acoustic Environment

1) Acceptance/protoflight test duration = 1 min
2) Qualification test duration = 2 min

2.4 Random Vibration

Table 2-1Table 2-4 provides a set of random vibration levels for hardware design. The levels shown are the generalized random vibration environment defined in GEVS, Table 2.4-3. These levels are applicable to hardware weighing less than 50 lbs and having resonant frequencies greater than 80 Hz. The levels for hardware weighing more than 50 lbs may be reduced using the method specified in GEVS. Hardware with resonant frequencies below 80 Hz may be designed using only the MAC design loads specified in Section 2.1 as the MAC loads include the effect of mechanically transmitted random vibration up to 80 Hz. The random vibration levels given below should be updated based on test data or acoustic analysis of the payload once the launch vehicle specific acoustic environment has been defined.

Frequency (Hz)	Acceptance	Protoflight/Qualification
20	0.013 g^2/Hz	0.026 g^2/Hz
20 – 50	+6 dB/Oct	+6 dB/Oct
50 – 800	0.080 g^2/Hz	0.016 g^2/Hz
800 – 2000	-6 dB/Oct	-6 dB/Oct
2000	0.013 g^2/Hz	0.026 g^2/Hz
Overall	**10.0 grms**	**14.1 grms**

Table 2-4: Random Vibration Levels (Less than 50 lbs) – All Axes

1) Acceptance/protoflight level random test duration = 1 min
2) Qualification level random test duration = 2 min

2.5 Shock Spectrum

Table 2-5 provides a generic shock environment that may be used for hardware design until the mission specific shock environments can be defined. Hardware shall be designed to withstand the shock spectrum environment shown in Table 2-5 without any damage or degradation of performance. The shock levels given in Table 2-5 assume that a component is located at least 60 cm (2 ft) from a shock source. The levels given below should be updated once all payload shock sources have been defined.

Frequency (Hz)	Acceptance Level (g)	Protoflight/Qualification (g)
100	160	224
630	1000	1400
10000	1000	1400

Table 2-5: Shock Response Spectrum (Q=10)

1) Shock testing performed by firing the actual device shall consist of 2 actuations for protoflight/qualification testing and 1 actuation for acceptance testing.
2) Simulated shock testing shall be performed to the levels specified in Table 2-4 with 2 tests per axis for qualification testing and 1 test per axis for acceptance/protoflight testing.

All components shall be assessed for damage due to shock based on shock sensitivity or proximity to shock sources. Components not considered susceptible to the shock environment may have shock testing deferred to the level of assembly that allows for actuation of the actual shock producing device. Any component considered to be susceptible to the shock environment should consider shock testing at the component level to demonstrate shock qualification.